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CAUSE RELATIONSHIPS OF COLLISIONS AND GROUNDINGS - RESEARCH PRO--ETC1

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CAUSE RELATIONSHIPS OF COLLISIONS AND GROUNDINGS — RESEARCH PROJECT CONCLUSIONS

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Abstract

Statistics show that 75% of Norwegian ship casualties are collisions and groundings. The cause is stated to be «human error» without any further explanation in about 80% of these incidents.

On this background the project tasks, which have been model and method development, analysis of about 3000 collisions and groundings, development of a manoeuvring simulator, near-miss analysis and evaluation of the idea of a data recorder for ships, were formed. The paper conclude on the different project tasks, list some general observations and indicate proposals on recommendations.

Indexing terms

Collisions
Groundings
Statistics

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The idealistic objective should be:

To avoid ship casualties

To avoid ship casualties leading to high consequences

- people injured or killed
- pollution
- loss of or damage to ship and cargo

Casualty is a symptom of malfunction of the organizing system which is responsible for coordination of all activities contributing to safety

Organizing is to get things done by help of people who cooperate towards a mutual goal

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The term "human error" is entering the picture at this stage, because "human error" is quoted as the dominating cause to ship casualties.

Therefore, to continue these thoughts, the following may be claimed:

- V The "human error" can be traced back to unsufficient leadership within planning, organization and control

This may be felt as an unfair simplification of the problem. But the meaning is that we can learn from accidents, and that it must be the responsibility of management to identify elements of risk and build up and inform about the safety program.

The conclusion of these thoughts about a safety philosophy is:

- VI Casualties happens because of "human errors" which can be traced back to unsufficient coordination and operation of the activity

Therefore, the obvious measure must be:

- VII A system or program must be defined, which minimize the "human error"

THE PROJECT APPROACH - The project "Cause Relationships of Collisions and Groundings" should be evaluated on the background of the preceding thoughts.

Fig. 1 illustrates the project approach, that the total picture must be evaluated when explaining a ship casualty, i.e. the ship system, the contribution from the environment and the society behind.

The analysis was limited to the most dominating group of ship casualties, namely collisions and groundings, which for Norwegian ships for the period 1977-78, constitutes about 75% of all reported casualties as shown in Fig. 2.

The research approach was:

- VIII to learn from accidents

This seems best achieved by analysing accidents to find the causal relationships:

- IX A causal relationship is a set of incidents, which under the given operational conditions, constitutes the defects of the system, and which generate the accident

On this background the project's main objective was formed:

Through studies of the error mechanism in manœuvring and navigating which leads to collisions and groundings, recommend means which will reduce the accident frequency.

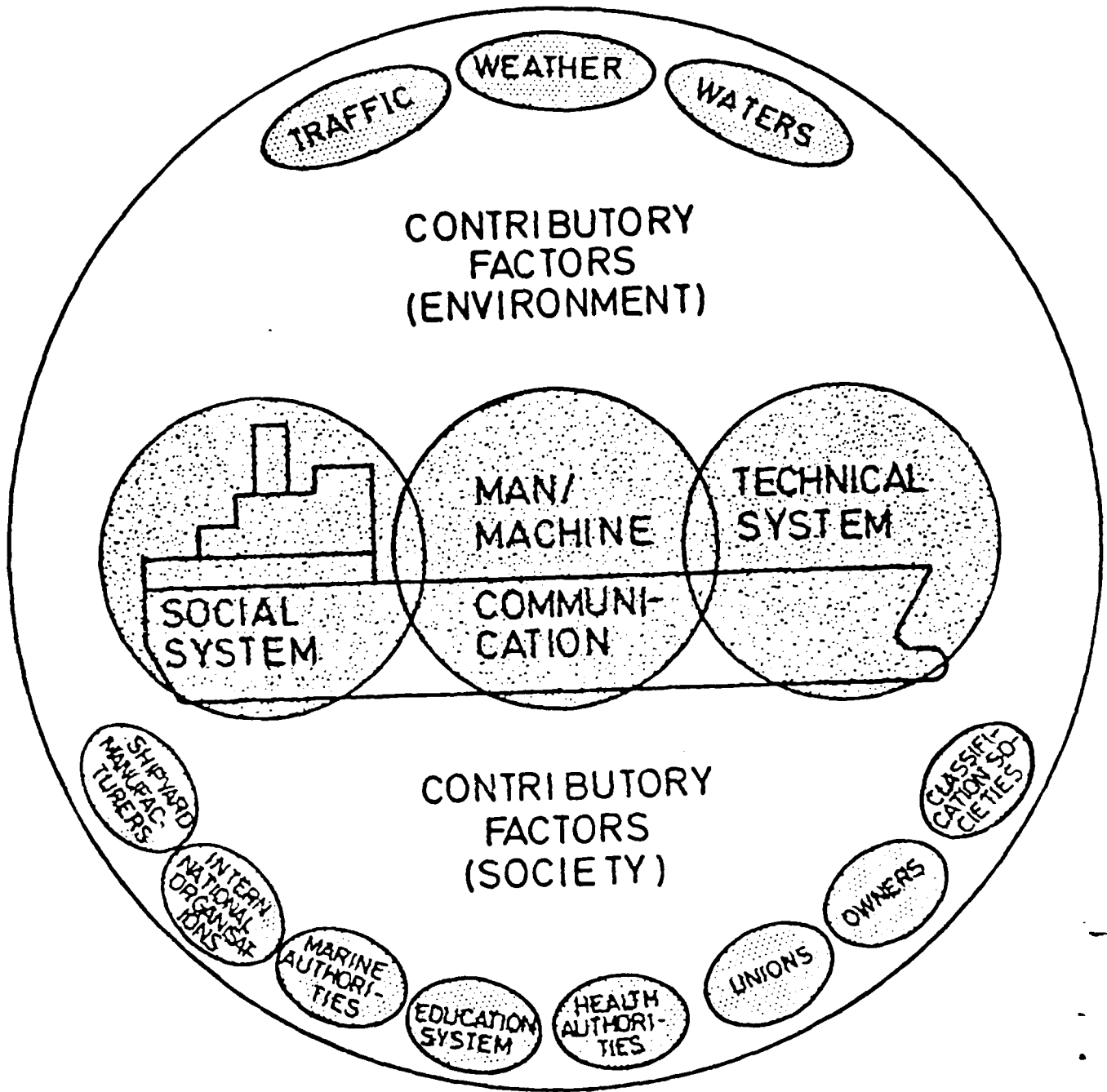


ILLUSTRATION
OF
PROJECT

Fig. 1

NORWEGIAN SHIP CASUALTIES 1970-1978

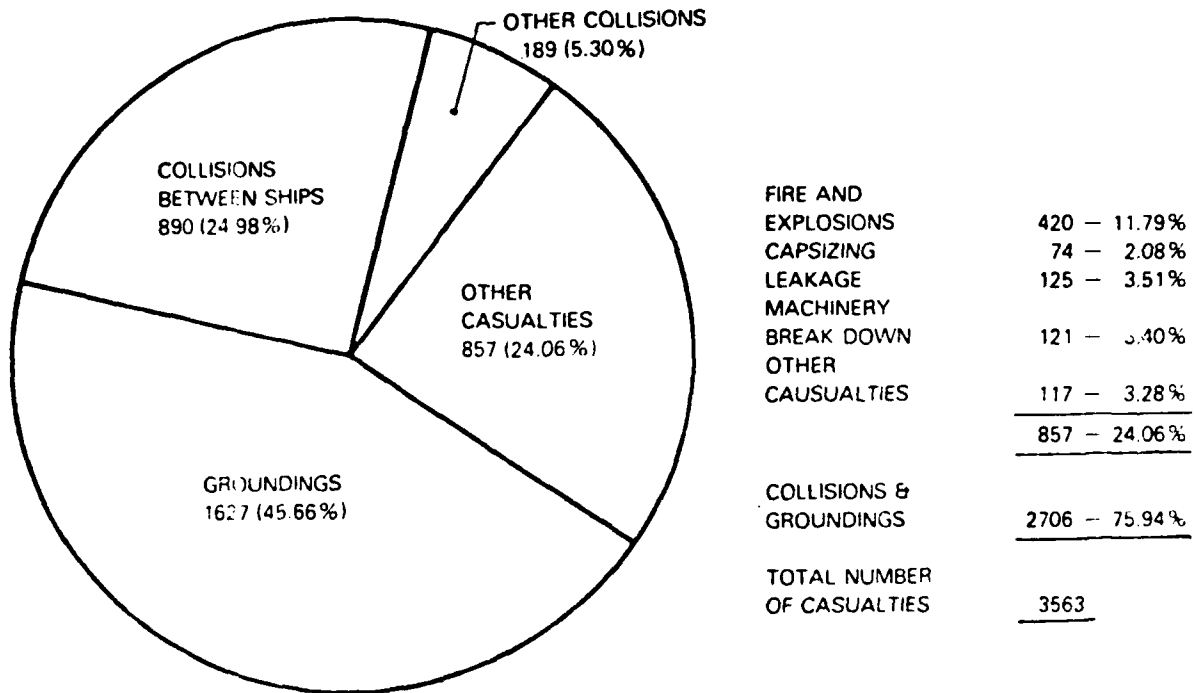


FIG. 2

THE PROJECT TASKS - A broad approach was felt necessary to identify which tasks were most important, and which the project team should concentrate upon.

In this searching process, the below list of goals were decisive for the final working tasks:

- Focus interest and debate on casualties
- Achieve cooperation with/between maritime institutions and authorities
- Enlighten the problem area
- Think internationally
- Achieve results which are useful to the maritime society and implement them during project lifetime

Fig. 3 shows the resulting working tasks.

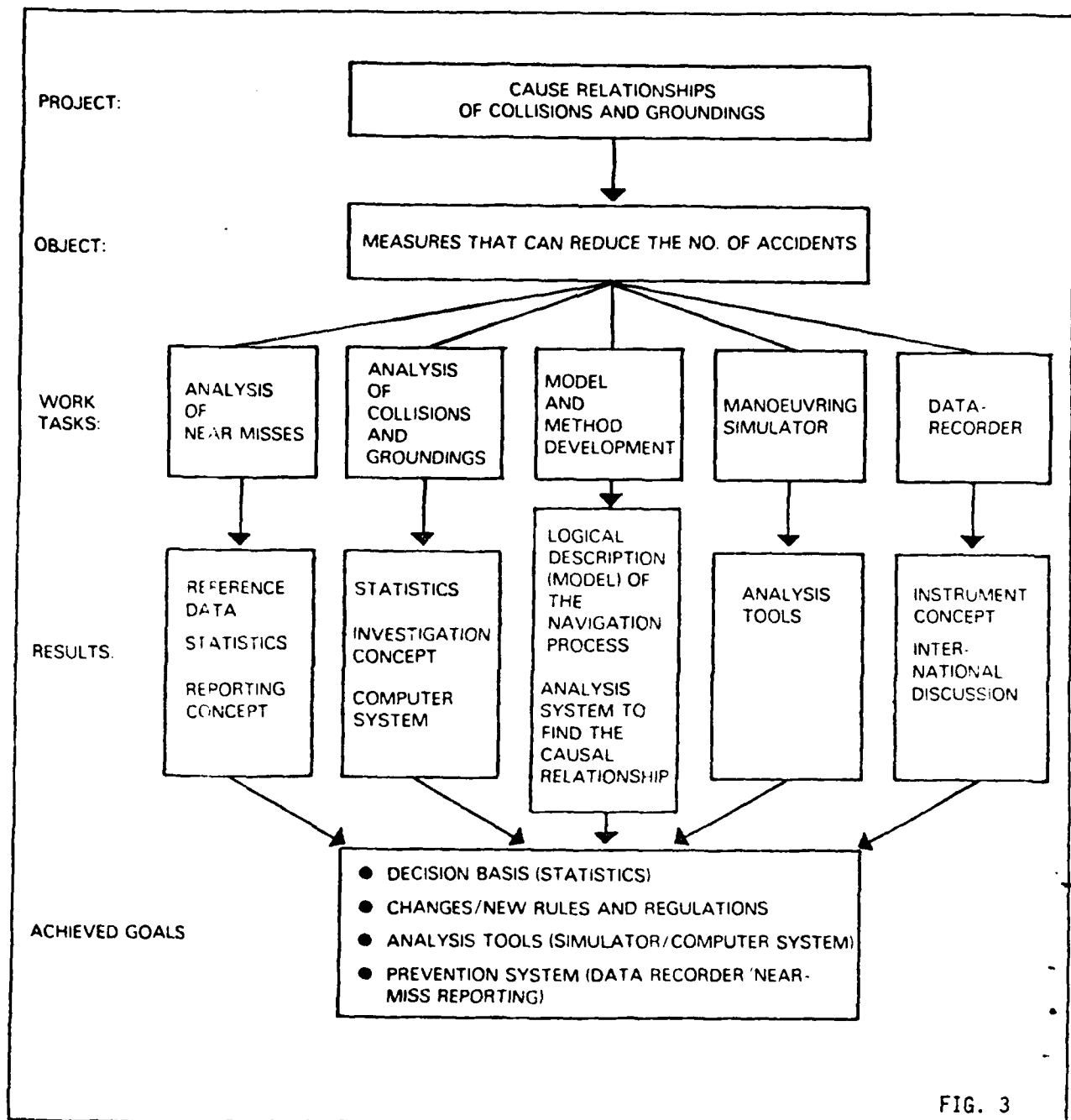
MODEL AND METHOD DEVELOPMENT - Recognizing the fact that approx. 300 collisions and groundings are reported to the Norwegian Authorities each year, and that 80% of these are due to "human error", it was found necessary to give special consideration to the human factors involved. This required an in-depth understanding of how such causal factors relate to the collision or grounding occurrence. In most accidents, there are several factors that may be identified as being contributory. These may be events like judgemental error, misreading, fog, missing navigation aids, radar failure, and so on. The actual combination of cause events differs widely from one accident to another.

The cause relationship of an accident is the sequence of inadequacies, failures and conditions that produces the event. Figure 4 illustrates how a cause relationship (which belong to one or more generic problem areas like technical failures, manning, organization etc.) may be composed of two main groups of events:

- a) Assumed risks: This includes contributory factors that are indeasible, impractical or undesirable to do something about, because they lie outside the Society's domain of control;
- b) Basic causes, denoting weaknesses that can be "controlled" through appropriate safety-related measures.

THE NAVIGATION PROCESS - A collision or grounding relates to the navigation and manoeuvring of a vessel in a waterway. The accident is considered to occur within a system called the navigation system. This consists of three basic elements: The vessel, the waterway and the navigator.

In this context, the term "navigator" means the person on the bridge actually planning the intended track and executing vessel control. The navigator is in fact a decision-maker in a close man-machine interaction. His decisions and subsequent actions are basically oriented towards a) controlling the vessel and b) gathering relevant information. Vessel control is achieved by manipulating rudder angle, engine revolutions, propeller pitch angle and perhaps bow thruster. Of these parameters, or control variables, the rudder angle is usually the most important.



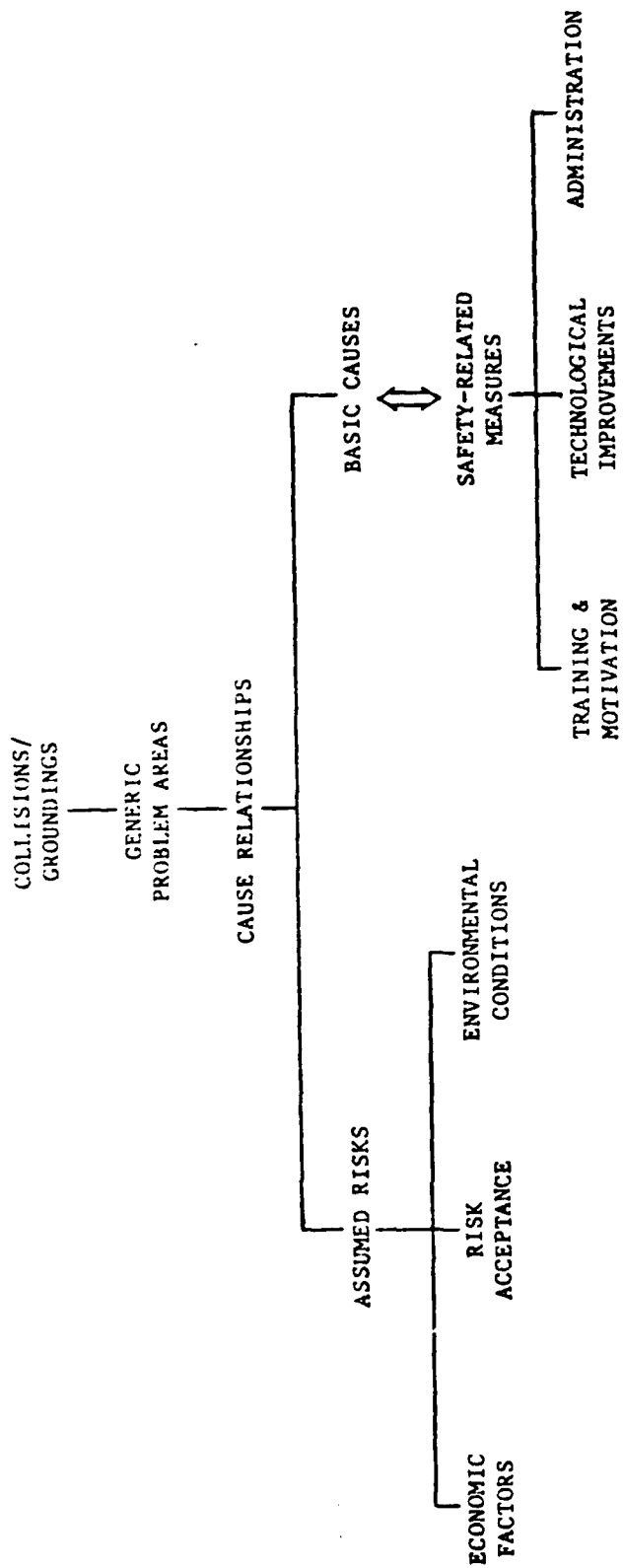


Figure. 4 Overview of the Collision/Grounding Problem Area

Physically, the effect of changing a control variable is to alter certain hydrodynamic forces acting on the ship. These combined with other forces set up by environmental influence from wind, current, waves, bank effects, ship/ship interactions etc., and with the ship's own inertia, to produce the resultant effect on the vessel state variables. These variables include geographical position coordinates, velocity components, heading angle (instantaneous true course), and rate of turn. Equipment, machinery and hull hydrodynamics all have their characteristic response times and behaviour. Technical malfunctions may have the effect of altering these parameters.

The physical and operational environment of the vessel is represented by the waterway element. The waterway configuration imposes physical constraints to the navigator's choice of track. Surrounding land and objects, lights, marks and other aids to navigation provide him with relevant information. Environmental conditions include weather and sea state, light etc. Traffic and regulations are also a part of the waterway element.

The flow of information from the vessel and waterway elements to the navigator closes the loop of the navigation system, as Fig. 5 indicates. The basis for his decisions is information about own vessel's state, which is derived or estimated from observing visual cues or radar picture and reading speed log and gyro compass, and waterway information which enables him to navigate the waters. In addition, he needs reference information from charts and Pilot books which allows him to interpret this.

The navigator can be thought of as a decision-making element which transforms information input into actions to bring the process to the desired state. To this end, he must have a mental idea about the behaviour of the ship and its response to control orders and external influences. This "mental model" represents his accumulated knowledge about the dynamic process he is controlling, and forms a basis for his decisions. New information about the ship's state will update the mental model to reflect the present state of knowledge of the navigator.

The mental activities carried out by the navigator may be characterized by the following list:

- Plan and schedule actions, observations, manoeuvres and orders to predetermined checkpoints or events related to the waterway;
- Monitor the development of the ship and track, passage of preplanned checkpoints, weather and traffic;
- Detect changes or observed deviations from expected values (i.e., predicted by the "mental model");
- Adapt and update the mental model to new situations when necessary;
- Gather information about own ship's (and other ships') position, course, speed, external influences etc. Check and confirm the information;
- Compare the actual state with the planned state;
- Predict future state, weather and sea influence, traffic pattern etc.;
- Decide the appropriate action or manoeuvre to bring the ship to desired state;
- Execute the decision.

The previous discussion establishes the basic concepts and framework of the navigation process.

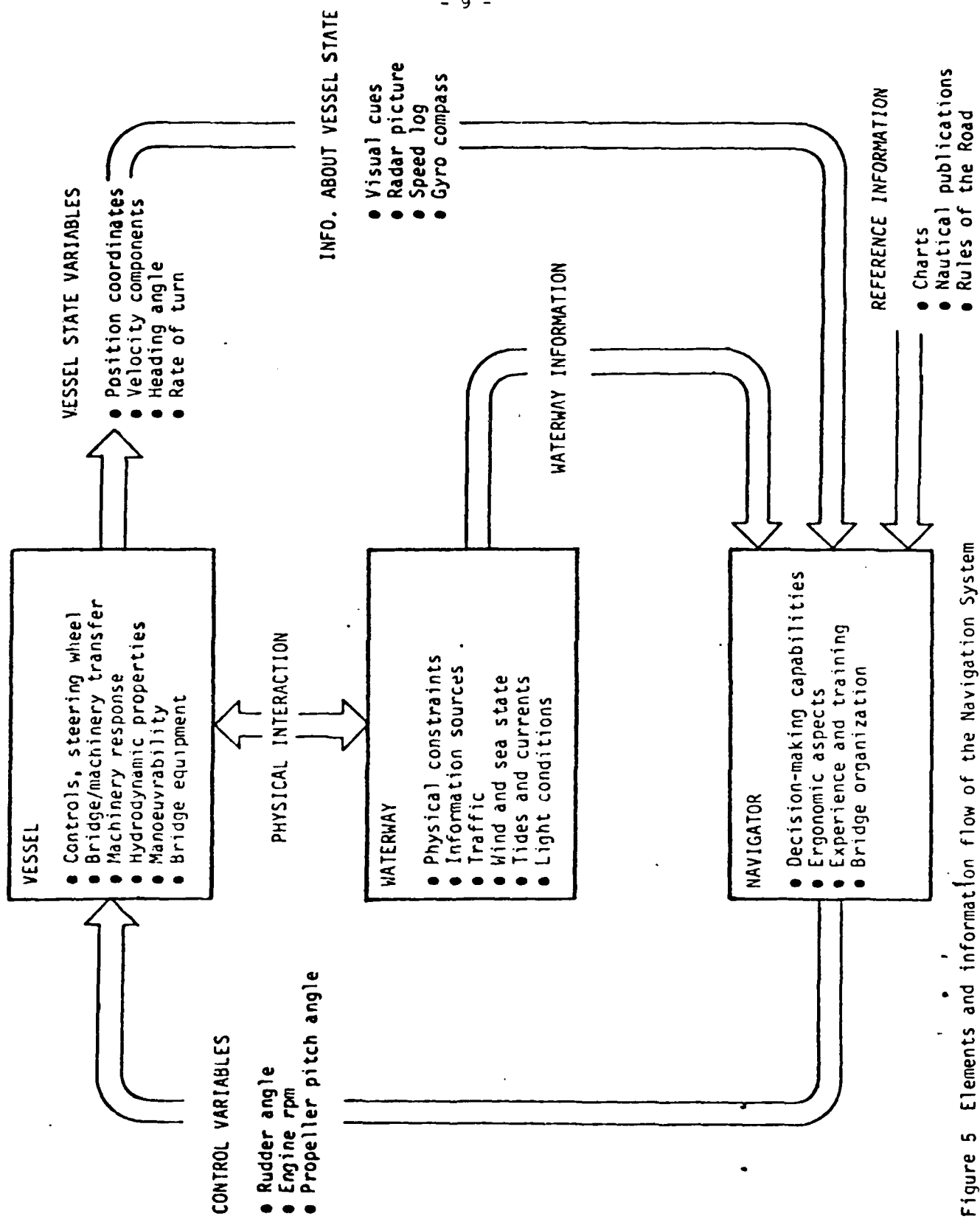


Figure 5 Elements and information flow of the Navigation System

To work out a more detailed model of the navigator's functions, a logic analytical tree is developed to show what elementary job tasks and basic information elements are necessary to perform successful navigation. Navigation may be defined as:

"Taking the vessel safely and efficiently from X to Y".

This ultimate objective can be broken down into subgoals of navigation (see Figure 6):

- A: Determine vessel's present position
- B: Identify and assess risks
- C: Plan future route
- D: Manoeuvre ship to desired state

These sub-goals must all be adequately carried out for successful navigation to take place. In the logical diagram in Figure 6 this is shown by an AND gate connecting the sub-goals to the ultimate objective. Each of these sub-goals are then broken further down into the various tasks, methods and procedures that may be needed to accomplish the goals. The analysis is carried on to a level of detail where elements of information flow, technical instruments, and single procedures are revealed.

COLLISION AND GROUNDING FAULT TREE - Determining the causes of an accident requires that some criterion exists for identifying malfunctions or weaknesses in the system in which the accident occurred. The definition of a malfunction or weakness must be related to an understanding of how the component or task is supposed to function. Therefore, one has to refer to some kind of model of how the system functions.

In purely technical systems, this reference model is provided by drawings, process flow diagrams, component characteristics etc. In socio-technical systems, where a human operator or decision-maker enters in a complex interaction with his technical environment, a functional system model is much less definable. Very often, this is instead replaced by an experienced investigator's knowledge about rules, regulations, normal standards, working routines, and established practice. This is the case with e.g. the Maritime Inspectors' investigation of an accident.

In this project, the primary reason for defining the system knowledge in a model was that it would provide a common framework for detailed statistical analysis of different accidents.

By this approach, the final statistical data will become more applicable to future risk analyses, because the implications and limitations of the data are better understood and therefore more easily transferable.

Modern accident theories often regard an accident as the result of a sequence of events or changes from a normal state. The potential for unwanted release of energy and resulting damage associated with a technological activity like e.g. marine traffic is controlled and inhibited by a number of technical, operational and administrative barriers. If these barriers break down, an accident will result.

Figure 6. The subgoals of navigation. The AND-gate indicates that all of these must be adequately performed

In accordance with this accident philosophy, the model and method development in this project has been focussed on how to deal with statistical treatment of cause relationships rather than single accident causes. A cause relationship is defined as a set of events which under given operational conditions represent weaknesses in the system and are sufficient to generate the accident. A vast number of conceivable cause relationships exist in collisions and groundings. A pre-defined list of possible cause relationships would be useful for an in-depth statistical analysis, but this would be practically impossible to do manually.

Fault Tree Analysis appears to be a suitable approach to this problem. The fault tree starts out with the top event (Collision/Grounding), and proceeds in a deductive manner to develop underlying causes, from the generic to the specific. The logical relationship between an event and its underlying causes are indicated by means of AND gates and OR gates, similar to the analytic tree discussed in the preceding chapter.

Fig. 7 shows the general structure of the collision/grounding fault tree. The structure is chosen such that it reflects the development over time of the accident: The uppermost level events immediately precedes the top event, while the lower level events are more remote in time.

SIMULATION OF THE HUMAN ELEMENT - Changes in cargoes, trade and technological development often leads to new and larger vessels. Planning the new trade may include new ports and port facilities especially designed for the vessels, but normally the new and larger ship types will use existing ports and waterways. Thus, manoeuvring margins will tend to decrease. Less room is left for both normal and abnormal variations in vessel track, and consequently the degree of precision with which navigation can be carried out becomes more important. This will depend on the adequacy of information about the waterway that is supplied to the navigator.

It is therefore of great interest to be able to predict and quantify a ship's capability to navigate a given waterway successfully under various environmental conditions.

This problem requires systematic experimentation as well as theoretical analysis. However, real-world experiments (real ships in the actual waterway) are generally not feasible. Simulation studies with physical small-scale models are widely used in hydrodynamic laboratories to determine manoeuvring properties. Increasingly, simulation of manoeuvring characteristics are being based on computers. The "computer models" consist of computer programs that describes mathematically the dynamic equations governing the motion of the ship. When a set of control orders and the appropriate hydrodynamic data are provided, the simulation model will calculate the track of the ship.

Such a simulator can be useful for many purposes, including assessment of navigating margins in a given waterway, assessment of ramming risks due to black-outs etc. A total assessment of grounding risks due to measurement uncertainty, incomplete information, time lag in navigational information and control actions, human decision errors etc. will, however, require that human operator behaviour and navigation information flow is incorporated in the simulator in addition to vessel hydrodynamics and environmental disturbances.

To implement this in a computer is a complex task. The model presented in this paper would be very applicable as a starting point and framework for this.

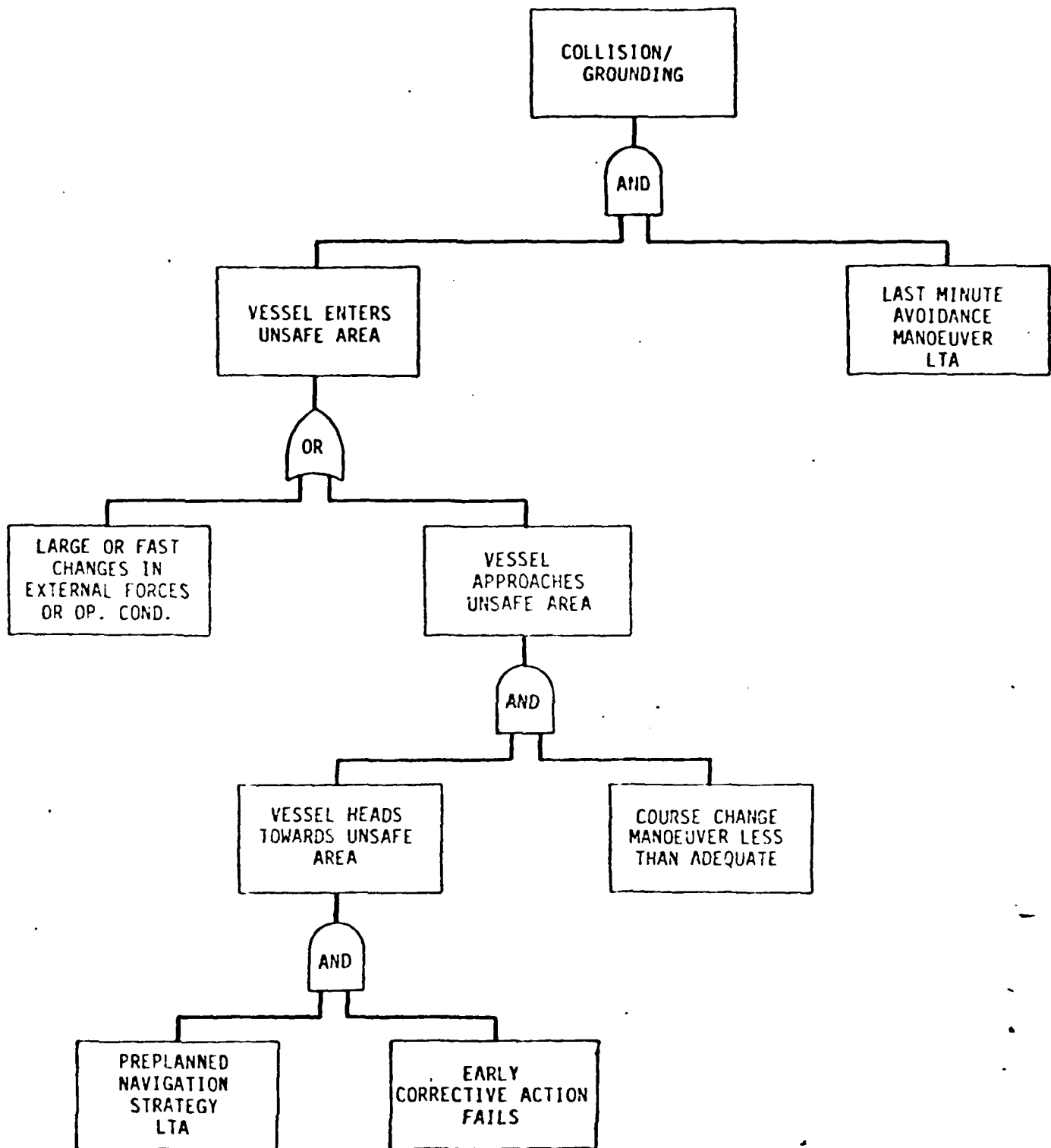


Figure 7 General structure of a Collision/Grounding Fault Tree

ANALYSIS OF COLLISIONS AND GROUNDINGS - It was realized at an early stage in this research project that few or no data on ship casualties suitable for analytic purposes were available. It was therefore decided to go through the documentation from the maritime declarations with the intention to form a statistical basis for subsequent, in-depth analyses.

The investigation was limited to Norwegian registered ships down to 25 gross tons involved in collisions, ramming and groundings in the years 1970 - 1978.

It should be borne in mind that maritime declarations primarily are carried out for legal purposes and that data collected from such documentation therefore may be biased in various respects.

The collected data were coded by means of a registration form based on a list of descriptive variables and stored in a data-bank structured and implemented for this project. Table 1 describes the data structure.

Table 1 Data on collisions and groundings

Data group	Data items
Accident characteristics	Day/hour, location Ship identification, data cargo Accident type (collision/ramming/grounding)
External conditions	Lighting Weather Wind, sea state Fairway characteristics
Ships' manning conditions	Crew size No. of navigators Manning of the bridge Bridge watch system
Causal factors	Effect of external conditions System failures or deficiencies Failing navigational conditions Navigational errors Negligence Errors of other ships

Table 2 shows the casualty frequency distributed by tonnage based on the average number of ships and average number of casualties per year for the period investigated.

Table 2 Average No. of ships and No. of casualties per year for the period 1970 - 1978 with casualty frequency distributed by tonnage

Gross tonnage	No. of ships	No. of casualties	Casualty frequency (%)
25 - 99	3 584	476	1.5
100 - 299	1 243	120	9.7
300 - 499	420	47	11.2
500 - 1499	215	22	10.2
above 1499	938	62	6.6

It appears from this table that the casualty frequency for ships below 100 gross tons is surprisingly low. This may be attributed to the fact that reliable statistics of number of ships at risk were not available for the period concerned. We have further good reasons to believe that a great number of casualties - especially groundings - concerning ships in this tonnage group are not reported. Consequently, not too much weight must be placed on the figures for the smaller ships.

The table shows that the casualty frequency is practically the same for the tonnage groups between 100 and 1499 gross tons with an average rate of 10%, while the average frequency for ships above 1499 gross tons is 6.6% for the same period.

It is natural to assume that the substantially higher casualty frequency for vessels below 1499 gross tons is related to the fact that their trading routes expose these ships to a higher casualty risk, particularly with regard to groundings. Whether watch conditions, sailing routines etc. have been contributory factors will be dealt with in later studies.

From Table 3 it appears that the collisions represent a relatively greater share of the casualties for the larger ships.

Table 3 Percentage distribution of type of casualties by gross tonnage

	Below 100	100-299	300-499	500-1499	Above 1499	Total
Collisions	33%	29%	31%	37%	41%	33%
Rammings	3%	5%	9%	7%	13%	7%
Groundings	64%	66%	60%	56%	46%	60%
All casualties	100%	100%	100%	100%	100%	100%

While collisions and groundings are in the proportion of approx. 1 to 2 for the smaller ships, the share is about equal for ships above 1599 grt.

This may partly be related to the prevailing conditions under which these smaller ships are operated, but it may also be related to the manoeuvring aspect associated with the larger ships.

EXTERNAL CONDITIONS - Accident research is to a large extent occupied with adverse weather conditions as an explanatory factor (Wheatley 1973). Table 4 gives a statistical summary of the findings concerning external conditions. It clearly shows that only a marginal part of the accidents can be attributed to adverse circumstances.

The observation that 54% of the accidents took place at night is not significantly different from what we would have expected from pure chance. Fog can be observed roughly 1% of the time in Norwegian waters.

Table 4 External conditions during accidents

Condition-parameter	Relative frequency of adverse condition factor
Lighting	Darkness: 54%
Weather	Fog, haze, mist: 12% Rain, snow: 22%
Wind	Gentle breeze or stronger wind: 15%

This figure compared with the 12% of "fog-accidents" in this investigation shows that fog is a critical factor. We must, however, also conclude that fog is not present in majority of accidents (88%). A greater number of accidents take place under conditions of rain and snow, but the observed frequency of 22% is not higher than prevailing weather-conditions indicate.

Wind forces of gentle breeze and above was observed in only 15% of the accidents.

On the basis of the observed circumstances of these accidents it is possible to conclude that extreme weather conditions only explain a marginal number of the collisions and groundings. The understanding of the accident process ought to be based on a wider perspective taking other conditions such as aids to navigation, bridge design, bridge manning in terms of number and competence, bridge procedures and not least, causal factors into consideration. The next paragraph exemplifies one of these conditions.

MANNING OF THE BRIDGE - The analysis of manning conditions was based on very limited information. The main findings are summarized in Table 5.

Table 5 Manning conditions during accidents

Condition parameter	Relative frequency of condition factor
Watch system	3-watch system: 20%
Watch system	2-watch system: 49%
	Other watch systems: 31%
Number of Deck-officers on the bridge	One deck-officer: 68%

It can be seen from the table that "2-watch system" and "other systems" are dominating. By "other watch systems" are meant shift arrangements and ships with no formal watch routines. These two systems are typical for ships below 1599 gross tons. The 2-watch system implies 6 hours on watch which is a considerable period. The investigation does not show conclusively whether these watch systems are significantly more hazardous or that the higher accident frequency simply follows from the fact that these systems prevail on smaller ships.

It is also evident that ships manned with one deck-officer is especially vulnerable. One officer may not cope with all tasks during critical periods, and inadequate performance due to reduced vigilance and fatigue will not be monitored or detected. In this connection it may be worth while to note that 158 accidents took place because the officer on watch fell asleep.

In all these cases the bridge was manned with one officer only and all the accidents except one refer to ships below 1599 gross tons.

CAUSAL FACTORS - The potential number of causal factors associated with collisions and groundings is high. On the outset of the investigation 21 groups of factors were identified. Each group consisted of roughly 10 basic factors. This gave an investigation form with 210 different causal factors.

Table 6 gives an overview of the 21 causal groups arranged in 6 cause areas or fields with the registered frequency of causal factors shown both in absolute and relative figures.

It can be seen from this table that the three most important cause areas for the total investigation are:

1. Effect of external conditions
2. Navigational errors, and
3. Negligence

These three areas account for 74% of the accidents. Later analysis will show that the importance of these areas varies with the tonnage groups.

Table 6 No. of causal factors per group arranged in fields of cause

Fields of cause	Causal groups	Frequency	
		Abs.	Rel. (%)
I Effect of external conditions 27.6	G. External conditions which reduce the efficiency of navigational aids	86	1.5
	I. Fault, deficiency or misleading information from lights and marks	114	2.1
	P. Reduced visual conditions	797	14.3
	Q. External effects, canal- and shallow water effects	539	9.7
II System failures or deficiencies 6.6	A. System failures - ship's system	143	2.6
	C. System failures - navigational aids	74	1.3
	D. System failures - remote control	130	2.3
	E. System failures - communication systems	22	0.4
III Failing navigational conditions 8.2	B. Bridge design and arrangement	48	0.9
	F. Error or deficiency in charts or nautical publications	113	2.0
	M. Inadequate bridge organization	111	2.0
	O. Inadequate internal communication	35	0.6
IV Navigation errors 25.5	X. Inadequate experience and competence	152	2.7
	R. Errors in navigation or manoeuvring	936	16.8
	T. Confusion of/did not use information from fixed objects (lights, landmarks etc.)	256	4.7
	S. Faulty operation of equipment	119	2.2
V Negligence 20.7	U. Wrong appreciation of traffic information	101	1.8
	N. Errors in the conduct of navigation	758	13.7
VI Errors of other ships 11.4	V. Special human factors	389	7.0
	H. System failures or deficiencies on the other ship	62	1.1
	Y. Navigational errors on the other ship	575	10.3
100.0		5 560	100.0

Table 7 The principal causal groups

Causal group	Relative frequency
R. Errors in navigation or manoeuvring	16.8%
P. Reduced visual conditions	14.3%
N. Errors in the conduct of navigation	13.7%
Y. Navigational errors on the other ship	10.3%
Q. External effects, canal- and shallow water effects	9.7%
V. Special human factors	7.0%
T. Confusion of/did not use information from fixed objects (lights, landmarks etc.)	4.7%

Similar to the cause areas the relative importance of the causal groups will vary with the type of accident and the tonnage groups. Table 7 shows the seven most important causal groups on the basis of the complete investigation material.

SEGMENTATION OF THE ACCIDENTS - Inspection of the accident data made it clear that the investigation contained a heterogenous material. It covers ship sizes from below 100 grt to more than 100.000 grt. Both inland traffic and foreign trading are represented. Formal crew qualifications, manning systems and degree of professional seamanship varied considerably.

Preliminary studies of each accident type showed significant variations with respect to dominating causal factors. This is illustrated in Figure 8 where the identified factors are grouped in five areas. It appears that technical failures plays a role in contact damages (16%). The principal causal factors of groundings are negligence. Causal factors referred to navigation tasks seem to be general elements in the "accident-picture". The interaction with other traffic will obviously be important for collisions.

These observations lead to segmentation of the accidents on the basis of ship size and accident type. Figure 9 shows the 5 accident segments that will be analysed in this project. From practical reasons and limited resources in the project, accidents of vessels under 100 grt had to be dropped at this stage.

Table 8 illustrates how the total number of 2742 accidents is distributed on the defined segments. It appears that groundings and collisions of ships in the region 100 - 1599 grt stand for respectively 40.6% and 19.6% of the accident material. Then follows groundings and collisions of ships above 1599 grt. The smallest group is ramming with 6.6%.

Table 8 Percentage distribution of accidents on segments

Accident type	Gross register tonnage		
	Below 100	100 - 1599	Above 1599
Grounding	11%	40.6%	8.4%
Collision	5.8%	19.6%	7.5%
Contact	0.6%	6.6%	

Figure 8 Cause factors distribution - the main areas for each casualty type

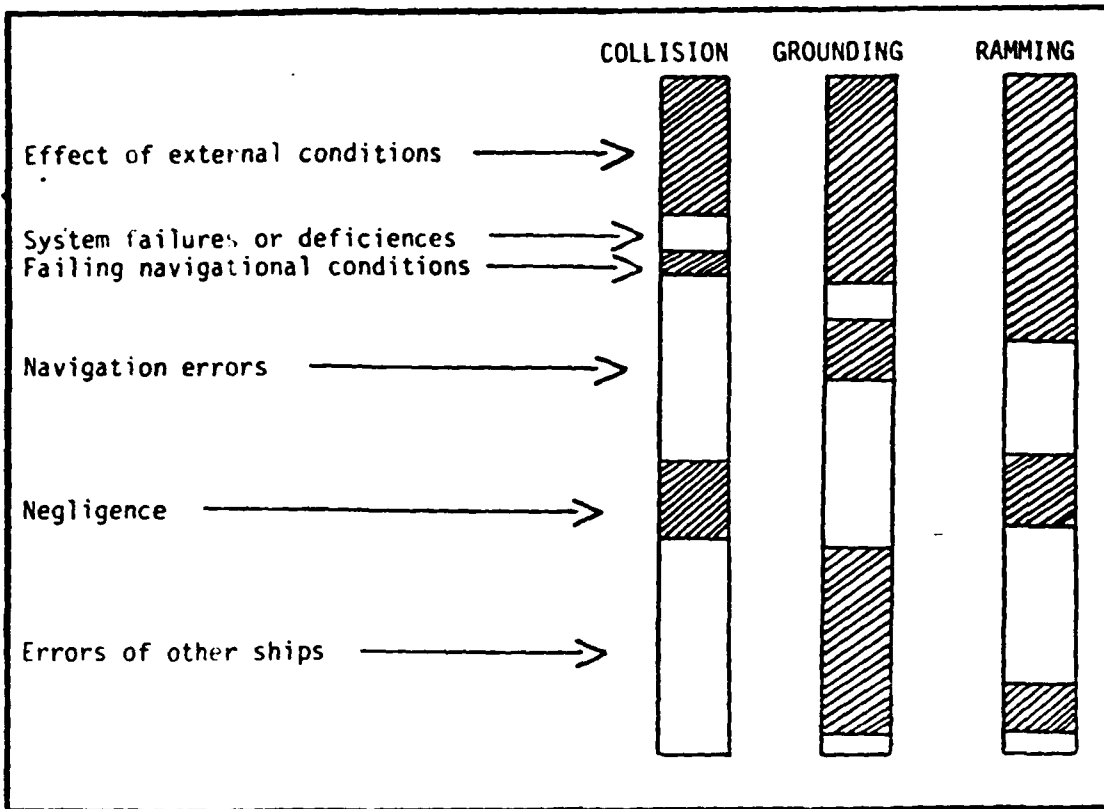
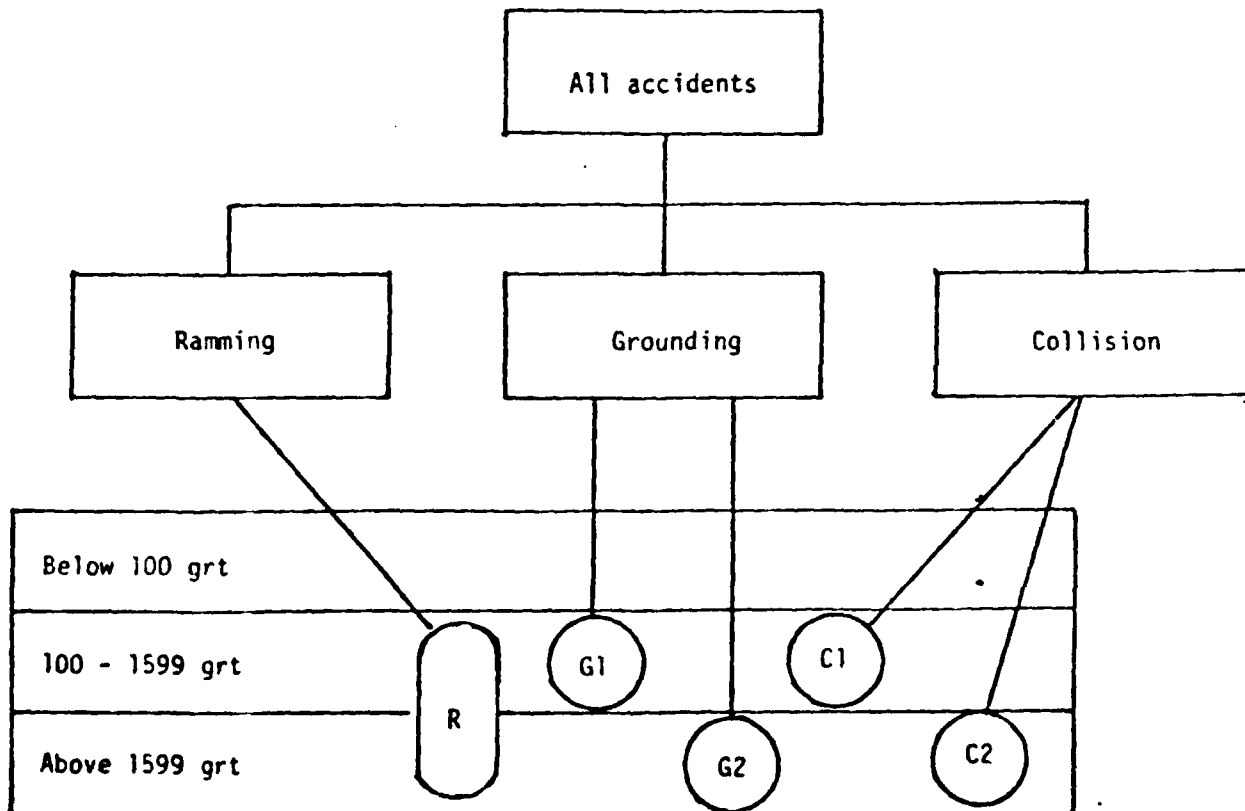


Figure 9 Segmentation of the accident-material



The recommended measures will then be addressed to the different tonnage groups as shown in table 8.

MANOEUVRING SIMULATOR - To determine manoeuvring characteristics and their influence in accident situations, a simulator was developed, that will be used to examine manoeuvring characteristics of ships in different waters and for different conditions.

This simulator, named SAILSIM, shown in Fig. 10, is now being used for reconstruction of an accident through simulation of a tanker grounding on the Norwegian Coast. The purpose is to evaluate the risk of navigation in restricted waters, i.e. the Norwegian Coast, and form recommendations on navigational aids and navigational procedures on board, to reduce the risk.

NEAR MISS ANALYSIS - The project's initial step for this sub-task was to propose a near-miss reporting form as shown in Fig. 11.

The immediate response from the navigators on this request form was rather cool. Their response was that they disliked to be informers. Therefore another approach was made by a questionnaire to be used in interviewing navigators to register their opinions on the causes of collisions and groundings. The form enables the navigator to express his general opinions, and on what he believes to be the causes of casualties, or to report a near-miss, or to report his opinion of causes in an actual casualty.

Approx. 60 forms have been distributed, and 11 forms have been returned completed.

This response must be characterized as rather uninspiring, and this has also influenced the further work with this subtask.

However, the completed forms will be analyzed to see if these reports supports the conclusions from the collision and grounding analysis.

However, a near-miss reporting should have a potential success, if given more considerations and follow-up, as have been the case in this project.

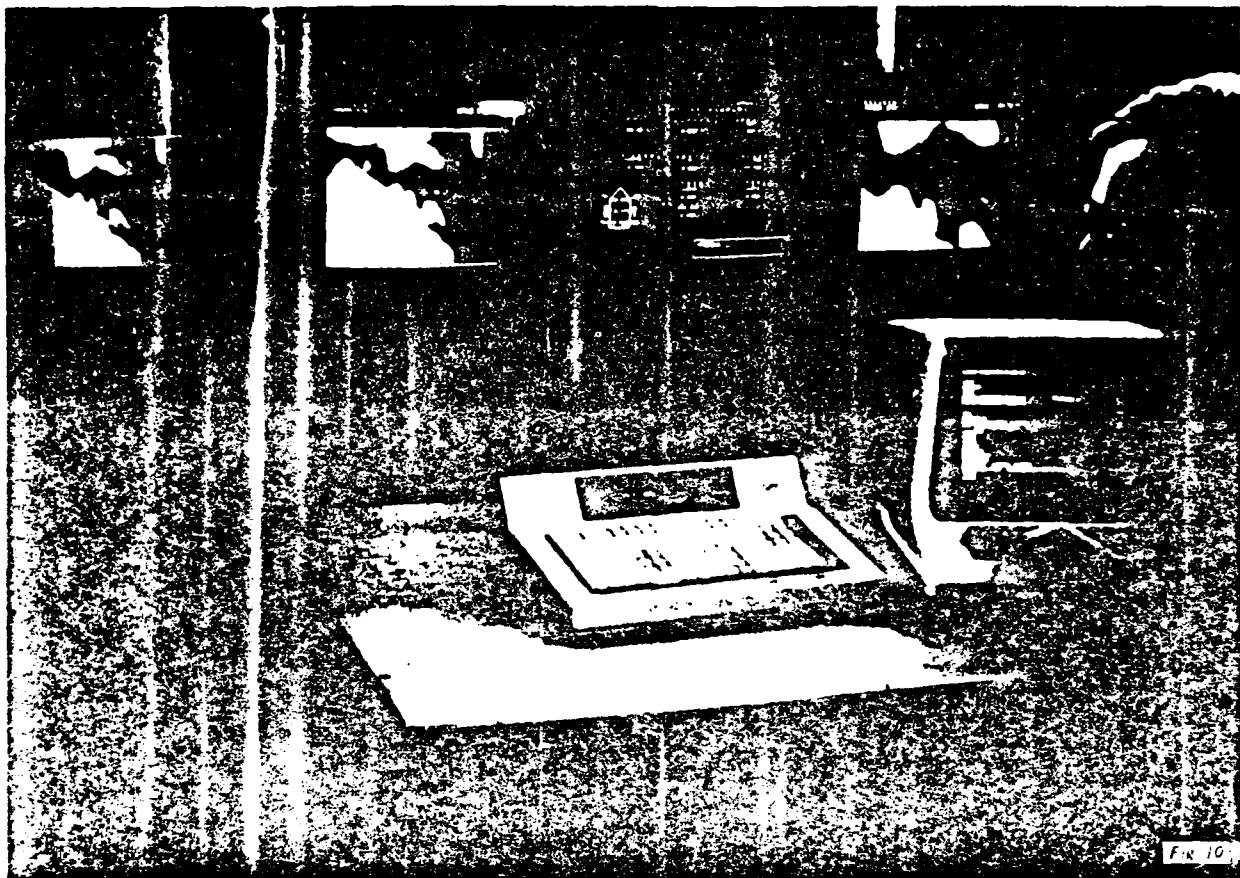
Therefore the initial proposal on a near-miss reporting scheme stands as a result still to be tried and evaluated.

DATA RECORDER FOR SHIPS - A question which stands central in the investigation of maritime accidents is:

To what degree does one succeed in acquiring correct and complete information on the sequence of events?

It helps very little to have an effective investigation effort and an up-to-date analysis system if one does not manage, however, to collect the correct and complete information on the sequence of events.

This is and will continue in the future to be the nucleus in maritime accident investigations, and in this connection, as in aviation, the question of the data recorder is topical. A data recorder would be able to take care of the necessary information on a ship's movements prior to an accident and record possible communication on the bridge. This would be invaluable information in being able to clear up many accidents. Such a unit could be released and float to the surface on the loss of the ship. If the data recorder did send out distress signals, one could also be able to locate it.



The simulator system SAILSIM

INCIDENT REPORT FORM

FORM PAGE 1

Nature of Incident:			
Occured at (location):			Date and time:
Own Ship:	Name:	Type:	Destination:
Other Ship or Ships Involved:	Name (if known):	Type:	Destination:
Submitted by:			
On duty as:			

REPORT

FORM PAGE 2

- 1) Conditions existing at the time (weather, visibility, navigation, equipment in use)

- 2) Nature of the Incident:

- 3) Action taken prior to and in avoiding the accident:

- 4) Suggestion as to procedures that might avoid such incidents:

- 5) Any other comments:

INCIDENT REPORT FORM

FORM PAGE 1

Nature of incident:			
Occured at (location):			Date and time:
Own Ship:	Name:	Type:	Destination:
Other Ship or Ships Involved:	Name (if known):	Type:	Destination:
Submitted by:			
On duty as:			

REPORT

FORM PAGE 2

- 1) Conditions existing at the time (weather, visibility, navigation, equipment in use)

- 2) Nature of the Incident:

- 3) Action taken prior to and in avoiding the accident:

- 4) Suggestion as to procedures that might avoid such incidents:

- 5) Any other comments:

The project group has presented this idea before several international forums, and gradually received a broad consensus. A note was laid before IMCO by the Norwegian delegation, and the data recorder was discussed in the "Sub-Committee on Safety of Navigation" during spring 1980.

The sub-committee expressed the following opinions:

- Voice recording on the bridge would be particularly useful
- Recovery in deep water would be difficult
- Shipmasters should be protected against legal liabilities
- Careful consideration should be given to the possible advantages of recorders
- Analogy with flight recorders may be misleading
- Recording of course and speed through the water could be an initial measure
- The data recorder concept revives the question of an exchange of information on ship casualties between the different maritime administrations

The sub-committee requested members to consider the need for a recorder and, if such a need exists, the data which should be recorded. Members were also requested to submit their comments and proposals to the sub-committee's next session.

The project group realizes the necessity for international acceptance of the idea, so that the data recorder does not become negative evidence in an economic struggle, but can give a positive contribution to explain accidents at sea and thereby give the possibility to prevent recurrences.

The project group therefore see IMCO as the right authority to follow-up this idea, because it is an international concern, and that automatic registering onboard by help of a data recorder will preserve the key information for revealing the accident. It will also act as a deterrent, and will, without doubt, contribute to reduce the number of accidents.

THE PROJECT AND THE MARITIME SOCIETY - The project ideas was born in 1976, when both the Norwegian Coast Directorate (KD), and Det norske VERITAS applied to the Royal Norwegian Council for Scientific and Industrial Research (NTNF), for financial support for 1977 for research and development projects.

KD's idea was through investigation of ship casualties on the Norwegian Coast to analyze if lights, buoys, markers, pilots etc. was concluded as causes, and then to use the statistical findings when allocating resources to KD's different fields of responsibility.

VERITAS wanted to find out what caused the high number of ship collisions and groundings, which was dominating world wide casualty statistics, and to consider the ship rules in light of the findings and the classification societies role in the effort to reduce the number of accidents.

The NTNF-project, 3S - System for a Safe Ship, then asked KD and VERITAS to cooperate to form a common project with an objective which would cover the interest of both institutions.

Based on this background the project

"Cause Relationships of Collisions and Groundings"

was formed, and the whole Norwegian maritime society was invited to support the project, by participating in a hearing group.

The hearing group should then be a forum for discussion and evaluation of project ideas and results and for exchange of information.

The following list of institutions reflects the support the project met in the Norwegian maritime society:

1. Norwegian Maritime Directorate
2. Norwegian Coast Directorate
3. The Directorate for Seamen
4. Norwegian Hydrographic Office
5. Royal Norwegian Ministry of Church and Education
6. Norwegian State Pollution Control Authority
7. Norwegian Institute of Technology
8. Institute of Transport Economics
9. Norwegian Shipowners' Association
10. Norwegian Shipmasters' Association
11. Norwegian Mates' Association
12. Norwegian Seamen Union
13. Norwegian Pilots' Association
14. The Norwegian Association of Nautical Experts
15. Norwegian Mutual Hull Clubs Committee
16. The Central Union of Marine Underwriters
17. Civil Aviation Administration
18. Nordic Institute for Maritime Law
19. Royal Norwegian Council for Scientific and Industrial Research
20. Royal Norwegian Navy
21. Central Bureau of Statistics
22. The Ship Research Institute of Norway
23. Norwegian Coastal Liners' Association
24. Norwegian Society for Sea Rescue
25. Norwegian Coastal Freighters' Association
26. Det norske VERITAS

The hearing group has been a valuable resource for the project group and an effective way of spreading information. For a research project, it may be questioned if such an overhead organization may slow down the research progress, and that the debate may be destructive because of organizational or political issues. However, in this case the opposite must be advocated. By exposing ideas continuously for such a critical group and asking opinions, many facets of ideas are revealed and the conclusions and results are understood and in the most cases accepted before project documentation. This has also forced the project to be highly result oriented, and being able to deliver and incorporate results within the project's duration. It was also felt that the project's willingness to expose the research underway, was welcomed positively from organizations in the maritime society, who seldom was asked their opinions in similar projects. This created the positive atmosphere, which has been very stimulating for the project.

The financial support has been very good, totalling about 5.1 mill. NOK for the project period 1977-80, with the following contributions:

	(1000 NOK)
Norwegian Maritime Directorate	275
Norwegian Coast Directorate	816
Norwegian State Pollution Control Authority	275
Leif Høegh & Co. A/S	54
NTNF-PFO	325
NTNF-SK	110
NTNF-3S	1 135
The Central Union of Marine Underwriters	50
Det norske VERITAS	2 028
Total	5 168

The Norwegian maritime society has been heavily engaged in the project as reflected above.

However, "Safety at Sea" is an international concern, and therefore the project ideas also have been exposed internationally through papers and presentations, and have been met with interest.

IMCO has been an important target for exposure of project results. As described above, the concept of a data recorder for ships was introduced for IMCO, and is now been given the necessary international considerations, to see if it can be a valuable tool contributing to increase "Safety at Sea".

In 1980 a steering group on casualty statistics was formed in IMCO, which met first time during Maritime Safety Committee's 42nd session. Norway was represented in the steering group, and the project's report "Statistical survey of collisions and groundings for Norwegian ships for the period 1970-78" was discussed in the group, and the report was also considered by the Sub-committee on Standards of Training and Watchkeeping.

It is felt that the international maritime society welcome the exposure of the project, and that it will initiate other activities leading to international cooperation in this area.

CONCLUSIONS AND OBSERVATIONS - It seems right to recall the project's main objective before summing up:

"Through studies of the error mechanism in manoeuvring and navigating which leads to collisions and groundings, recommend means by which to reduce the accident frequency".

This is an ambitious goal, which the project will answer in the following way:

- List of recommended measures for different tonnage groups
- List of project achievements, being a basis for recommendation on measures
- General project observations
- Proposals on follow-up

The list of recommended measures will be a result of the analysing phase which is at present not finished, and will be documented in the project's final report.

However, the project has been a diversified activity, and when searching for measures for 4 years, quite a few "spin-off products" may be claimed as important results, both operational system and system concepts.

- A logical model of the navigation process may be used as a basis for a nautical school book
- A model of the human element may be used for simulation studies
- A casualty data base
- A statistical presentation concept for ship casualties
- A casualty investigation concept
- A casualty registration form "Report on Casualty"
- A data system concept
- Casualty statistics and accident cases as a basis for courses in accident prevention
- An off-line simulator of ship manoeuvring
- International discussion in IMCO on data recorder for ships
- Contribution to the discussion on an IMCO casualty statistics scheme
- Institutional cooperation on investigation of casualties

During the project period some general observations have been made by the project group. It is felt to be of importance to communicate these observations, and below is listed areas, which will be covered in the project's final documentation.

- Responsibility for and the enforcement of safety for navigation
- Investigation of casualties and criminal prosecution
- Maritime Accident Commission
- Analysis of accident data
- The maritime declaration and the truth v.s. a data recorder
- Safety and manning
- The Marine Underwriter's role and responsibility for safety at sea
- IMCO and international responsibility for enforcement of safety at sea compared with ICAO (aircrafts)
- Training and refreshment courses to maintain the navigators necessary level of expertise

In 1977 the project's main objective and goals were formed. The project period was estimated to 4 years and a funding of about 4 mill. was agreed.

The project is finalizing this year. The project has done its best to fulfill the objectives and reach the goals. The project costs are about 5.1 mill.; 1.1 mill. more than estimated.

It is now important that the project's recommendations and observations are considered seriously by the institutions responsible for the particular areas concerned.

Furthermore it is important to continue the work for "Safety at Sea", and the final report will recommend areas to follow-up and fields to dig deeper into.

For follow-up projects the below recommendations is experienced to be of vital importance:

- National coordination
- Cooperation by parties involved
- International discussion and cooperation
- Action on recommendations by responsible institution

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REFERENCES

Drager, K.H., Verlo, G., Thackwell, J.A., Karlsen, J.E., "Study of Relationships between Different Causes of Collisions and Groundings". 3rd International Symposium on Marine Traffic Service, Liverpool 1978. VERITAS Report No. 78-081.

Drager, K.H., 1979, Project description: Cause Relationships of Collisions and Groundings. Høvik: Det norske VERITAS, report No. 79-0554.

Drager, K.H., 1980, Project: Cause Relationships of Collisions and Groundings. Annual Report 1979. Høvik: Det norske VERITAS, report No. 80-0295.

Karlsen, J.E. & Kristiansen, S., 1980, Statistical Survey of Collisions and Groundings for Norwegian Ships for the period 1970-78. Høvik: Det norske VERITAS, report No. 80-0199.

Wiencke, P.M., 1979, Shipping Accident Analysis: The Need for an Operational Model of the Navigation Function. Preprint from the conference 3rd International Symposium on Ship-Operation Automation, Tokyo 26-29 November 1979.

Wiencke, P.M., Karlsen, J.E. & Kristiansen, S., 1980, Collisions and groundings analysis: An Operational model of the ship system and the navigator's functions. Preprint from the conference "West European Technology Conference, Sandefjord 2-6 June 1980.

Kristiansen, S., 1980, An investigation of collisions and groundings with emphasis on cases and contributory factors. Preprint from the conference "International Conference on Ergonomics & Transport by the Ergonomics Society", University College of Swansea, 8-12 September 1980.

Drager, K.H., 1980, Investigation of accidents at sea - some points of view. Oslo, VERITAS No. 99, 1980.

Kirkvaag, T.B., 1980, Tanker omkring et flytryggingssystem, Oslo.

Wheatley, J.H.W., 1973, Circumstances of Collisions and Strandings. Marine Traffic Engineering Conference, organized jointly by RINA and RIN, London.

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